REMARKS

The Office Action dated October 28, 2008 has been reviewed, and reconsideration of the application and allowance thereof are requested based on the following remarks.

The abstract and the specification have been amended to cure grammatical and idiomatic errors contained therein. No new matter has been added.

In order to expedite the prosecution of the present application and respond to the formal rejections made by the Examiner, Claims 1-3, 5-12 and 14-20 have been amended to more particularly point out and distinctly claim the subject matter which Applicants regard as the invention, or to cure grammatical and idiomatic errors contained therein. New Claims 21-28 have been added. New Claims 21-28 incorporate the subject matters of Claims 1-3, 10-12 and 19-20, respectively, with some modifications. It is respectfully submitted that the currently presented claims contain no new matter and are cured of all formal defects. Applicant submits that all of pending Claims 1-3, 5-12 and 14-28 are in condition for allowance. No new matter has been added.

Claims 1-3, 5-12 and 14-20 have been rejected under 35 U.S.C. §101 because the claimed invention is directed to non-statutory subject matter. Independent method Claims 1 and 6 are directed to a tiling method for culling small object in a system for shading 3-dimensional computer graphics images, and thus Claims 1 and 6 is tied to the system, that is a particular apparatus. Independent means plus function Claims 10 and 15 obviously contain specific means to perform the functions. Dependent Claims 2-3, 5, 7-9, 11-12, 14 and 16-20 are also allowable as depending upon allowable Claims. Further, the Supreme Court upheld patent claims that included use of a computer, *Diamond v. Diehr*, 450 U.S. 175 (1981), even though the invention included use of an algorithm. Also, the Federal Circuit Court held that although the invention, implemented by a computer program for an investment structure

for mutual funds, used an algorithm, it was patentable subject matter because it produced a useful, concrete, and tangible result, *State Street Bank & Trust v. Signature Financial Group*, 149 F.3d 1368 (Fed. Cir. 1998). The present invention also produces a useful, concrete, and tangible result, and thus is within the subject matter of 35 U.S.C. §101. As such, it is believed that the currently presented claims clearly meet the requirements of 35 U.S.C. §101.

Claims 1-3, 5, 10-12, 14, 19 and 20 stand rejected under 35 USC §103(a) as being unpatentable over Redshaw et al., GB Patent 2 343 603 A in view of Deering, U.S. Patent No. 6 624 823 B2. Applicants respectfully traverse this ground of rejection and urge that the presently claimed invention is patentably distinguishable over the prior arts cited by the Examiner.

Claim 1 of the present invention is directed to a tiling method for culling small objects in a system for shading 3-dimensional computer graphics images, comprising the steps of:

subdividing a display on which an image is to be viewed into a plurality of rectangular areas;

deriving a list of objects in the image which may be visible in each of the rectangular areas;

determining maximum and minimum values for each object in the list in x and y directions;

determining a minimum set of sampling points for the object from the maximum and the minimum values;

surrounding the object with a bounding box;

determining if the bounding box covers any of the sampling points;

culling the object if the bounding box misses all of the sampling points;

testing each of the sampling points in the minimum set against each edge of the object if the bounding box does not miss all of the sampling points; and

culling the object in the system for shading 3-dimensional computer graphics if the object does not cover any of the sampling points.

On the other hand, Redshaw teaches a method for shading 3-dimensional computer generated images, comprising the steps of:

representing each object in the image as a set of polygons;

dividing the image plane on which the image is to be displayed into a plurality of rectangular areas;

supplying data defining the location of each polygon;

determining which rectangular areas are required to show the whole of the polygon;

for each pixel in each rectangular area, determining a depth value for the distance of a surface of the polygon from the image plane, determining whether the surface is visible at that pixel, and shading the pixel in dependence on the result of the determination.

Specifically, Redshaw is concerned with minimizing the total number of tiles or rectangular areas which will require processing. In this regard, Redshaw teaches, at page 7, lines 34-36 through page 8, lines 1-11, that it is only necessary to process the objects which intersect with a particular region or area (i.e. a tile). A triangle is utilized to represent the vertices of the object, and a bounding box is generated from this triangle and effectively defines a rectangular area within the screen which contains the object. The bounding box for the object is utilized to obtain a list of tiles located within the bounding box. This list of tiles is a subset of all the tiles within the screen and approximates the tiles which intersect with the object. Redshaw is thus concerned with determining a minimal set of tiles with which the triangle representing the object to be rendered crosses, and then only processes those tiles when rendering the object so as to improve processing efficiency. Thus, the purpose of the

invention disclosed in Redshaw is to reject tiles which are not necessary for rendering the object.

Redshaw is also concerned about determining which surfaces intersect particular rectangular areas within an image and improving processing efficiency by processing only surfaces which intersect a particular rectangular area for that tile. A tile comprises a plurality of pixels. Thus, once a surface has been determined as being potentially visible within a tile, each pixel in the tile must be processed to determine whether or not the surface is in fact visible at that pixel, irrespective of the size of the surface.

The present invention is concerned about disposing of objects if they become too small, to make a significant contribution to the final image. The object list-deriving steps in Claim 1 of the present invention are carried out so that small objects, which have no significant impact on the overall scene being rendered, are not rendered. The above steps embody a two-stage process which in the first stage will cull the object if a bounding box surrounding the object misses all of the sampling points and, in the second stage, each sampling point is tested against each edge of the object and it is determined whether or not the object covers any sampling point, and then the object is added or rejected from the list as a result of this determination. This is completely different from the purpose of Redshaw's invention, which as understood is not concerned with rejecting objects from an object list corresponding to a rectangular area or tile and therefore avoiding having to render these objects as is the case with the instant invention, and instead is concerned with rejecting tiles which do not intersect with the object so as to avoid having to process these tiles at all.

As for the step of deriving the list of the objects in the image which may be visible, Redshaw discloses in page 2,

lines 21-23 that a display list of the surfaces which fall that tile is used to define objects within the bounding box. Thus, Redshaw teaches the display list of the surfaces rather than the visible object list.

As for the step of determining maximum and minimum values, Redshaw disclose in Figures 6-10 various examples of different triangles with different bounding boxes, and different numbers of tiles required to display them, rather than teaching the calculation for the maximum and the minimum values for the objects.

The Examiner states that Redshaw does not explicitly teach the remaining steps, and cites Deering so as to allegedly cure the deficiencies.

Deering discloses a method for displaying graphical images, the method comprising:

computing a first octant identifier word for a first edge of the first triangle;

computing a second octant identifier word for a second edge of the first triangle;

determining a first orientation for the first triangle using the first octant identifier word and the second octant identifier word;

performing rendering computations on the first triangle in response to the first orientation equaling a rendering orientation value, wherein results of said rendering computations are usable to form an image on a display device.

Deering, like Redshaw, is concerned with determining a minimum number of bins or tiles which must be rendered, and not with rejecting an object from an object list from a rectangular area or tile if the object is determined to be too small such that it would not have a significant impact on the overall scene being rendered as is the case with the present invention.

As for the step of determining the minimum set of sampling points for the maximum and the minimum values,

Deering discloses in column 21, lines 32-35 that rendering unit may determine a subset of spatial bins which, based on their positional relation to the given triangle, may contribute samples that fall within the given triangle. Deering does not determine the minimum set of the sampling points, and further does not use the maximum and the minimum values to determine the minimum set of sampling points.

As for the steps of determining if the bounding box covers any of the sampling points, and culling the object if the bounding box misses all of the sampling points, Deering disclose in column 29, lines 27-33 that if the slopes are the same, the triangle is degenerate, and that degenerate triangles can be explicitly tested for and culled, or, with proper numerical care, they may be forwarded to succeeding rendering stages as they will cause no samples to render. However, the degenerate triangle is not the same as a small object triangle for which the present invention avoids processing. The degenerate triangle of Deering can be forwarded to succeed in rendering stages. Deeering does not show the process whereby the bounding box of the degenerate triangle or the area of the triangle is used to determine whether or not the box or area covers any samples. Instead, the tests of Deering are based on the slope M13 and M23, and the tests are determined by the triangle orientation rather than by the size of the triangle. Deering does not teach disposing the small objects.

As for the step of testing each of the sampling points in the minimum set against each edge of the object if the bounding box does not miss all of the sampling points, Deering discloses in column 30, lines 10-14 that rendering unit may determine which of the third-stage sample positions reside within the triangle being rendered, and also discloses in column 30, lines 56-58 that rendering unit may perform inequality testing on the third-stage sample positions as

described above for all three edges of the given triangle. However, Deering does not teach the testing based on whether or not the bounding box misses all of the sampling points, and Deering does not disclose the testing for each of the sampling points in the minimum set.

As for the step of <u>culling the object</u> if the object does not cover any of the sampling points, Deering discloses in column 58-62 that if a sample position lies on the accept side of all three edges, it is in the interior of the triangle, and rendering unit may set a VALID bit for the sample position. Also, in column 32, lines 39-42, Deering shows that rendering unit may compute ordinate vector for a sample only if the sample is inside the triangle as indicated by the sample VALID flag. In column 35, lines 11-13, Deering further discloses that the rendering unit may comprise a sample evaluation unit SEU to compute ordinate values for each valid sample in the candidate bins. However, Deering does not teach culling the small objects. Instead, Deering is more concerned about determining which pixels within the rectangular area are intersected by a particular triangle, and thus the process forms part of the rendering stage rather than a pre-rendering culling stage.

Accordingly, Claim 1 is believed to be patentably distinguishable over Redshaw and Deering, alone or in combination with one another.

Claims 2, 3, 5 and 19 depend upon what is believed to be an allowable Claim 1, are believed allowable therewith, and include additional features which further distinguish over Redshaw and Deering. For example, Claim 2 includes the steps of determining whether or not separation of the sampling points in the x and the y directions exceeds a resolution of the display, and adding or rejecting the object from the list based on a result of the determination. Deering teaches that samples may be filtered to form each pixel ordinate value, and

that a sample buffer may be configured to support super-sampling, critical sampling, or sub-sampling with respect to pixel resolution. However, Deering does not disclose the steps of determining whether or not the separation of the sampling points as defined in Claim 1 exceeds the resolution of the display, and adding or rejecting the object from the list depending on the result of this determination, because Deering as understood is not concerned with rejecting objects from object lists. The above filtering of the Deering invention is an image reconstruction filter used to upscale or downscale a sample image to target a particular resolution framebuffer, and thus is different from the small object culling of the present invention.

Claim 3 discloses that the resolution of the display comprises a pixel separation of the display. Deering does not teach the resolution of the display.

Claim 5 includes the step of, for each of the objects, selecting only those rectangular areas which fall at least partially within the bounding box of the object when determining whether or not that object is to be added to the list for the rectangular area. Redshaw does not teach the selection of the rectangular areas.

Claim 19 includes the step of determining whether or not the minimum set of the sampling points are spread by more than 2 x 2 pixels in the x and the y directions, wherein the step of testing the sampling points is not performed if the sampling points exceed this limit. Deering merely shows in column 9, lines 55-56 that samples may be filtered to form each pixel ordinate value rather than the minimum set of the sampling points spread by the pixel.

Claims 10-12, 14 and 20 are directed to an apparatus corresponding to the method of Claims 1-3, 5 and 19, respectively, and therefore Claims 10-12, 14 and 20 are

believed to be allowable over Redshaw and Deering for the same reasons as presented above relative to Claims 1-3, 5 and 19.

Claims 6-7 and 15-16 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Redshaw in view of Pearce et al., U.S. Patent No. 5 809 219.

Claim 6 is directed to a tiling method for shading 3-dimensional computer graphics images in a system for shading 3-dimensional computer graphics images comprising the steps of:

subdividing a display for each of the images into a plurality of rectangular areas;

for each object in the image, determining a bounding box of the rectangular areas into which the object may fall;

testing an edge information from each object against a consistent sample point in each of the rectangular areas to determine whether or not the object falls into each of the rectangular areas in the bounding box; and

inserting the object in an object list for the rectangular area based of a result of the determination,

wherein the step of testing the edge information comprises the step of shifting the edge information by a predetermined amount based on an orientation of each edge.

As for the step of determining <u>the bounding box of the rectangular areas</u>, Redshaw discloses in page 8, lines 7-11 that a bounding box for a particular object can be aligned to tile boundaries so that a list of tiles within the bounding box can then be obtained. However, Redshaw does not teach the bounding box of the rectangular areas. Instead, Redshaw teaches the bounding box for the object itself.

With respect to the step of inserting the object in the object list for a rectangular area, the Examiner points to Redshaw at page 13, lines 28-31, which read "[f]or each edge of the triangle, each tile in the rectangular bounding box must be processed in this way to decide whether or not it should be excluded from the minimal set." As discussed above with respect to Claim 1, this passage, contrary to the

Examiner's interpretation, pertains to the exclusion of a tile from a minimal set of tiles which should undergo processing, and not to any step which pertains to determining whether an object should be inserted in an object list for a rectangular area or tile, as recited in Claim 6.

As for the step of shifting the edge information by a predetermined amount, the Examiner points to Redshaw at page 13, lines 23-27, which read "[t]he comparison of the two values will indicate whether the point lies on the inside or outside of the edge. The interpretation of this result depends on the orientation of the edge as given in the table in Figure 9." The Examiner further explains that simpler mathematical operations would be achieved by shifting by a predetermined amount. However, at page 13, lines 28-31, Redshaw discloses that for each edge of the triangle, each tile in the rectangular bounding box, (not edge information from each object), is processed to decide whether or not the tile (not the object) should be excluded from the minimum set.

The Examiner states that Redshaw does not teach the step of testing the edge information from each object against the consistent sample point, and cites Pearce so as to allegedly cure this deficiency. In this regard, Pearce is directed to a method of simulating motion blur. Pearce, as understood, discloses motion vectors for the vertices in a three-vertex polygon that describe the motion of vertices as the three-vertex polygon moves from an initial to a final position. Pearce teaches a system and a method for simulating motion blur by identifying intersections of pixel sampling points with edges of moving polygons. The edges of the polygons of Pearce are moving as the polygons are moving, and thus Pearce does not pertain to shifting edge information of an object by a predetermined amount. On the contrary, the shifting step of Claim 6 is designed to allow the use of a consistent test corner for all edges rather than moving the test point as a

function of the edge, which results in lower cost implementations.

It is accordingly submitted that the invention taught in Pearce, as described above, is concerned with stationary sampling points with respect to moving polygons in order to produce a temporary anti-aliased motion blurred result. On the contrary, Claim 6 teaches testing edge information from each object against a consistent sample point, which testing includes shifting the edge information of the object depending on the orientation of each edge, so as to determine whether or not the object falls into each of the rectangular areas in the bounding box.

The Examiner explains that simplified mathematics is achieved by having a stationary sampling point rather than one that moves. The present invention uses the shifting step to achieve a safe calculation rather than to simplify the mathematics, as taught in the specification. Redshaw uses the expression of "y op mx+c", (where op is either less than or greater than), which differs from that used in the present invention, in that Redshaw requires additional special case testing for vertical edges where "m" approaches infinity. The present invention does not require such special case testing. The shifting of the present invention decreases the complexity of the hardware, for example, through removal of requirements for additional decisions made on a per-tile/per-edge basis. The present invention also allows for implementations using imprecise, that is, floating point mathematics to produce safe results. On the contrary, Redshaw as understood would require fully accurate mathematics in order not to accidentally leave some polygons out of tiles.

Furthermore, while Pearce teaches sampling an individual pixel against a triangle that is moving over a period of time in order to produce a temporally anti-aliased motion blurred result, it will be appreciated that the present invention does

not have the edges moving through time. Instead, the edges of the triangle are adjusted only once during an initiation phase with the amount of adjustment depending on the orientation of the edge. Then, a sampling of the shift triangle at the corner of the tiles determines whether the original triangle has any intersection with a tile.

Pearce particularly teaches the consistent sample point in each rectangular area whilst the claim requires shifting of the sample point. Redshaw teaches the use of a fixed sample point in relation to an edge rather than a shifting sample point. Thus, the combination is not proper.

As such, even if, for the sake of argument, the steps of Pearce pointed out by the Examiner were somehow combined with Redshaw, this would not result in a method which determines whether objects should be inserted in an object list for a rectangular area, as recited in Claim 6, since neither reference is directed to this feature. As such, the combination of Redshaw and Pearce is not believed to result in the instant invention as defined in Claim 6, and thus the combination is believed improper.

Accordingly, Claim 6 is believed to be patentably distinguishable over Redshaw and Pearce, alone or in combination with one another.

Claim 7 depends upon what is believed to be an allowable Claim 6, is believed allowable therewith, and includes additional features which further distinguish over Redshaw and Pearce. Claim 7 further discloses that the step of shifting the edge information comprises the step of <u>shifting by either a vertical or a horizontal dimension of the rectangular area</u>." Pearce discloses in column 4, lines 57-59 that one or more polygons on object are matched to the x, y coordinates of sample points. Pearce's motion vectors do not shift edge information or specifically <u>shift the dimension of a rectangular area</u>. Further, Pearce illustrates a two-dimensional projection into x, y coordinates for the three-

dimensional object rather than shift dimensions of a rectangular area.

Claims 15 and 16 are directed to an apparatus corresponding to the method of Claims 6 and 7, respectively, and are believed to be allowable over Redshaw and Pearce, for the same reasons as presented above relative to Claims 6 and 7.

Claims 8 and 17 stand rejected under 35 U.S.C. §103(a) as unpatentable over Redshaw in view of Pearce, and in further view of Vatti et al., U.S. Patent No. 5 265 210. Claims 8 and 17 depend upon what is believed to be allowable Claims 6 and 15, respectively, and are believed allowable therewith.

Claim 8 recites that the <u>shifting step is performed using a floating point calculation</u>, and Claim 17 recites means corresponding to Claim 8. While the present invention teaches that the <u>shifting the edge information is performed with a floating point comparison</u>, Vatti teaches the <u>floating point addition of the values to the coordinates of the address of the just-plotted pixel</u>. As such, Claims 8 and 17 are believed to be allowable over Redshaw, Pearce, and Vatti, alone or in combination with one another.

Claims 9 and 18 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Redshaw in view of Pearce, and in further view of Venkataraman et al., U.S. Pub. No. 2002/0180729 A1. Claims 9 and 18 depend upon what is believed to be allowable Claims 6 and 15, respectively, and are believed allowable therewith.

Claim 9 recites that the <u>shifting step is performed with a safety margin</u> whereby objects will be included in object lists for a rectangular area if the edge information falls close to a sampling point. Claim 18 discloses means corresponding to Claim 9. Venkataraman teaches that the circularity can be tested by picking three points on the cross edge and then <u>checking whether or not the sample points lie on a circle, within a tolerance</u>. The shifting step of the present invention has a safety margin during processing. The

Venkataraman invention, on the contrary, checks whether or not the sample points lie on a circle within a tolerance, rather than performing with a safety margin. As such, Claims 9 and 18 are believed to be patentably distinguishable over Redshaw, Pearce, and Venkataraman, alone or in combination with one another.

New independent Claims 21 and 24 includes the similar steps as disclosed in Claims 1 and 10, respectively, and therefore are believed to be allowable over the cited references for the same reasons as presented above relative to Claims 1 and 10. Claims 21 and 24 clarify that the culling of the objects is not restricted to images which are divided into a plurality of the rectangular areas. The invention disclosed in Claims 21 and 24 can also be used on an untiled image or as a pre-tiling stage to dispose of the smaller objects before the tiling begins.

Claims 22, 23 and 25-28 depend upon what is believed to be allowable Claims 21 or 24, and are believed allowable therewith.

For the above reasons allowance of the instant application is respectfully requested.

Respectfully submitted,

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